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Lamb Production of Dorper, Katahdin, and St. Croix Bred in Summer, Winter, or Spring in the Southeastern United States

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Summary

Ewe production traits and ability to breed out of season were compared for the Dorper (DO), Katahdin (KA), and St. Croix (SC) breeds between 2000 and 2005. Sheep were managed on grass pasture and were supplemented with corn/soybean meal and free-choice, trace-mineral mix. Ewes were exposed to rams of their respective breeds in late summer (August/September), winter (December), or spring (April/May) for 30-day breeding periods. Lambs were weighed at birth and 60 days of age. Pregnancy and lambing rates and litter birth weight were greater for all breeds bred in winter and lowest in spring. Pregnancy losses were greater and birth weights reduced for DO and KA ewes less than two years of age bred in the

spring compared with other seasons. Birth weights of lambs were not affected by season, but weaning weights were greatest for all breeds when ewes were bred in summer. Relative efficiency at weaning (kg of lamb produced/kg ewe weight) was greatest for summer-bred ewes and greatest for KA compared with DO and SC ewes. In summary, DO, KA, and SC ewes are capable of out-of-season breeding in Arkansas. However, relative efficiency and weaning weights were lowest for spring-bred ewes and fertility of yearling ewes of all breeds was reduced during spring breeding.

Key words: Dorper, Katahdin, Pregnancy, Production, St. Croix

Introduction

Numbers of hair sheep in the United States have increased in the past few years because of their ease of management. These sheep shed their hair, thus require no shearing, and are resistant to parasites (Courtney et al., 1985; Zajac et al., 1990; Gamble and Zajac, 1992; Burke and Miller, 2002), a trait of growing importance, especially in the southeastern United States. Because of resistance of gastrointestinal nematodes to chemical dewormers, resistant breeds of sheep represent an important control measure for these parasites. U.S. hair or shedding breeds include American and Barbados Blackbelly, Dorper, Katahdin and St. Croix, which are described (ASI, 2002) and reviewed by Wildeus (1997).

Out-of-season breeding is an important characteristic of sheep in the eastern and southeastern United States. Marketing potential increases with year-round supply of lamb, which can occur when multiple breeding seasons are included in reproductive management. Because sheep are short-day breeders, traditionally ewes are bred in the fall to lamb in the spring. Length of the breeding season is dependent largely on breed and latitude. Brown and Jackson. (1995) determined that St. Croix ewes were capable of breeding in the spring in Arkansas, but at a reduced rate compared with other times of the year. Dorper ewes were capable of year round breeding in South Africa (Schoeman and Burger, 1992).

Prolificacy is another important trait of sheep in the southeastern and eastern US. Lambing rate of St. Croix and Katahdin ewes was 140 percent to 212 percent, and 168 percent, respectively (Wildeus, 1997). Lambing rate of Dorper ewes in South Africa was 141 percent (Shoeman and Burger, 1992) and has not been reported in the United States. These lambing rates compare favorably with some of the moderately prolific wool breeds in the United States.

The objectives of this study were to examine ewe production traits and the ability to breed out of season among Dorper (DO), Katahdin (KA), and St. Croix (SC) ewes.

Materials and Methods

Animals and Their Management

The research site was located in west-central Arkansas at latitude of 35°N. The climate is characterized by hot, humid summers with little to moderate rainfall and mild winters with moderate rainfall. Annual precipitation is 112 cm.

The DO sheep used for these studies were derived from five purebred black-headed or white DO rams bred to either SC or Romanov ewes from this ARS station or to Romanov ewes from a private farm. These ewes were subsequently exposed to one of these rams (none bred to sires) or an additional two white DO rams. The percentage DO for each of the seasons is indicated in Table 1. The KA ewes originated from two farms (at least three genetic lines from one farm and commercial ewes from a second farm) and the rams from an additional two farms and within the flock for a total of four rams. The SC flock has been at the Booneville site since 1987, and replacement rams originated from within the flock and three additional farms. There were a total of nine SC rams used. Replacement ewe lambs were produced from within the flock.

Sheep grazed tall fescue (*Festuca arundinacea*), a cool season grass, or bermudagrass (*Cynodon dactylon*), a warm season grass, overseeded with annual ryegrass (*Lolium multiflorum*) for winter forage production. They were supplemented with corn/soybean meal (16 percent CP with added lasolocid; up to 500 g/d for growing lambs and up to 1 kg/d 30 d before and after lambing) and free choice trace mineral mix. Bermudagrass hay was provided during winter when forage was limited. Pastures were fertilized with N, P, and K as recommended based on soil tests.

Ewes were exposed to rams of their

breed type in late summer (August/September), winter (December), or spring (April/May) for 30 days. All rams passed a breeding soundness exam within 7 days before initial exposure to ewes. Rams were exposed to not more than 30 ewes during the breeding season. One ram was used per breeding season for SC and KA ewes between 2000 and 2002, and two rams per season in a single-sire mating was used in 2003 through 2005. Up to four DO rams per season were used in 2000 and 2001. In 2002 one ram per season was used for DO ewes, and in 2003 two rams were used for each season. Number of ewes for each breed type that were exposed in each season is indicated in Table 1. Ewes were exposed to rams at a minimum of six months of age. Ewes that lambd were re-exposed at eight-month intervals. Ewes that did not conceive were given a second chance at the subsequent mating cycle. Ewes failing to conceive after two consecutive opportunities were culled. Pregnancy was determined by transrectal ultrasonography (Aloka SSD 500 V ultrasound scanner equipped with a 7.5 MHz linear array prostate transducer; Aloka Co. Ltd, Japan) at the time of ram removal and 30 days later. Ewes were vaccinated against *Clostridium chauvoei*, *C. septicum*, *C. novyi* Type B, *C. haemolyticum*, *C. tetani*, and *C. perfringens* Types C and D (Covexin 8®) 30 days before the first ewe was due to lamb.

Ewes were transported to a lambing facility approximately 7 to 14 d before lambing. They were maintained outdoors on bermudagrass hay and grain supplement until lambing. When ewes lambd they were moved to individual pens with their lambs for approximately 24 h during which lambs were weighed, ear tagged, and had their navels dipped in iodine. The smallest lamb was removed from triplets after 24 h. Lambs were creep fed with the corn/soybean

Table 1. Numbers of Dorper (DO), Katahdin (KA), and St. Croix (SC) ewes exposed in summer, winter, or spring.

	DO ^a	3/4 DO	1/2 DO	KA	SC
Summer	5	42	64	106	83
Winter	9	39	2	102	85
Spring	16	60	81	93	112

^a Greater than 3/4 DO.

meal supplement starting at 30 days of age, and were weighed at 60 days of age.

All experimental procedures were reviewed and approved by the Agricultural Research Service Animal Care and Use Committee in accordance with the *NIH Guide for the Care and Use of Laboratory Animals*. Pain and stress to animals were minimized throughout the experimental period.

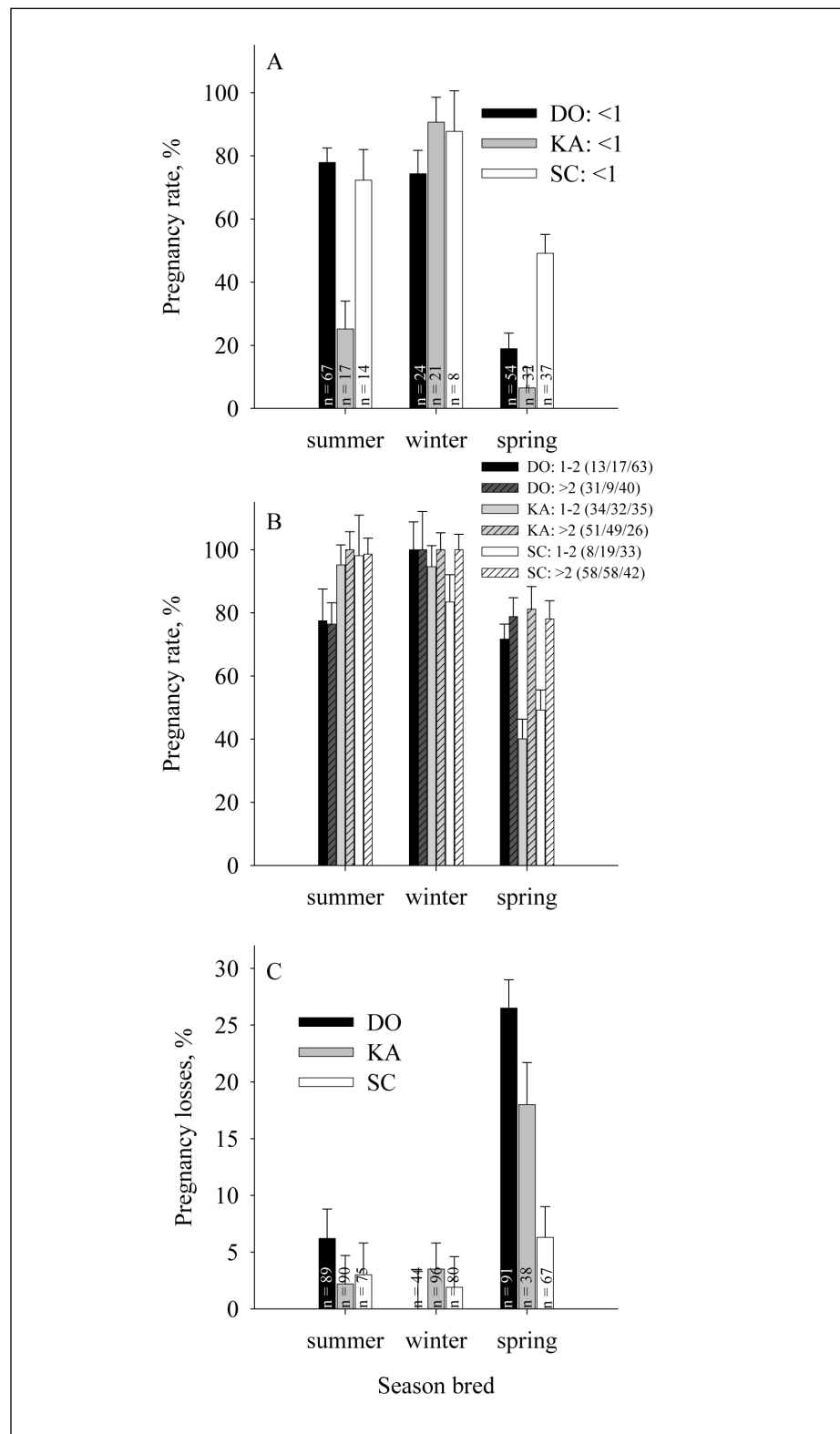
Statistical Analysis

Data were analyzed using the GLM procedures of SAS (1996) and means were compared using the PDIF option. Variables analyzed included body weight determined at breeding and weaning, pregnancy and lambing rate, individual weights of lambs, and relative efficiency of lamb production. For ewe production traits, the model included the random effects of breed, age of ewe at breeding (yearling or less than one year of age, one to less than two years of age, or \geq two years of age), season, and the interactions (two- and three-way), and year as a covariate. For lamb weights independent variables were breed, season, litter type, sex and any possible interaction. Birth order and year were included as continuous variables. If year was not significant, it was deleted from the model and observations among years pooled. Year was significant for pregnancy and lambing rates, litter birth weight of all ewes exposed, and individual weaning weights. Pregnancy rate was the proportion of ewes exposed to a ram that were pregnant at 30 days to 60 days of gestation. Percentage lambing was the proportion of ewes exposed that produced live or dead lambs. Percentage of lost pregnancies was the proportion of exposed ewes that were determined to be pregnant after ram removal that did not lamb. Percentage of lambs lost at birth was the proportion of lambs born that were dead or died within 24 hours of birth. Litter birth and weaning weights per ewe were the sum of weights within a litter. Relative efficiency was the weight (kg) of lambs produced per unit ewe weight determined at breeding multiplied by 100.

Results and Discussion

Pregnancy rate was greatest during winter breeding for all breeds and lowest in yearling ewes bred in spring (breed \times age \times season, $P < 0.001$; Figures 1A and

Figure 1. Least squares means and standard errors of pregnancy rate determined 30 days post-breeding in ewes that were < 1 (A), $1 - 2$, or ≥ 2 years of age at breeding (B; breed \times age \times season, $P < 0.001$) or pregnancy losses between 30 days post-breeding and lambing (C; breed \times season, $P < 0.001$) for Dorper (DO; black or dark gray bars), Katahdin (KA; light gray bars), and St. Croix (SC; white bars) ewes bred in summer, winter, or spring. Numbers of ewes are indicated within bars or next to legends in parenthesis for summer, winter, and spring breeding season, respectively.



B). For ewes exposed at <1 year of age, DO and SC ewes were more fertile than KA ewes bred in summer. Pregnancy losses were greatest in DO and KA ewes bred in spring (breed x season, $P < 0.001$; Figure 1C) and ewes bred in spring at < 1 year of age (age x season, $P < 0.001$; data not shown). Lambs born per ewe exposed (breed x age x season, $P < 0.001$; Figures 2A and B), proportion of exposed ewes that lamb (breed x age x season, $P < 0.001$; Figures 2C and D), and litter birth weights (breed x age x season, $P < 0.002$; Figure 3A and B) were greatest in ewes that were two years or older and lowest in spring-bred ewes. Litter birth weights were greatest for KA

and lightest for SC (DO, 5.4 kg; KA, 5.8 kg; SC, 5.1 ± 0.14 kg; $P < 0.002$) without any seasonal effects (Figure 3C). Litter birth weights increased with age (< 1 year, 4.4 kg; 1 to 2-year old, 5.2 kg; ≥ 2 years of age, 6.6 ± 0.14 kg; $P < 0.001$), partly because there were more single than multiple births from ewes < 1 year of age at exposure. In all breeds, ewes that were 2 years or older at breeding were more capable of out-of-season breeding than younger ewes. There were more DO (DO, 15.7 percent; KA, 3.1 percent; SC, 6.3 ± 2.6 percent; $P < 0.003$) and spring-bred (summer, 4.7 percent; winter, 5.4 percent; spring, 15.0 ± 2.5 percent; $P < 0.02$) ewes that lost

lambs during the first 24 hours of birth than other breeds or seasons.

There was some degree of seasonality in all breeds, as pregnancy rate was reduced during spring breeding. Out-of-season breeding for hair and shedding sheep has been reported by others. Brown and Jackson (1995) reported decreased pregnancy and lambing percentages in SC ewes bred in spring at the current location. The DO breed has been observed to breed out-of-season in South Africa in February/March and June/July with 51 percent and 56 percent, respectively, of exposed ewes lambing compared to October/November with 68 percent lambing (Shoeman and

Figure 2. Least squares means and standard errors for lambs born per ewe exposed (lambing rate; A and B) and proportion of ewes exposed to ram that lamb (C and D) for ewes that were < 1 (A and C), 1 – 2, or ≥ 2 years of age (B and D; breed x age x season, $P < 0.001$). Breeds were Dorper (DO; black or dark gray bars), Katahdin (KA; light gray bars), and St. Croix (SC; white bars) bred in summer, winter, or spring. Numbers of ewes are indicated within bars or next to legends in parenthesis for summer, winter, and spring breeding season, respectively.

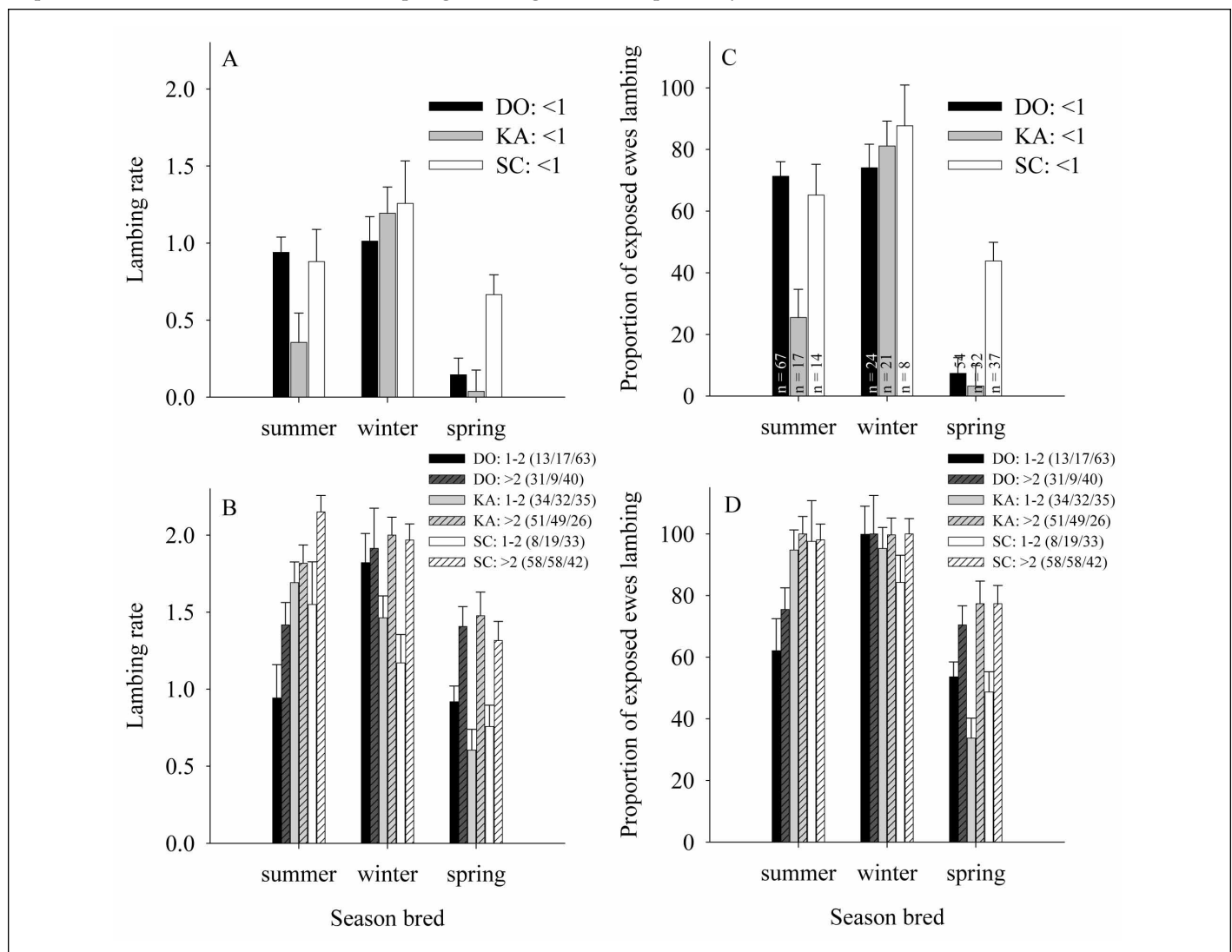
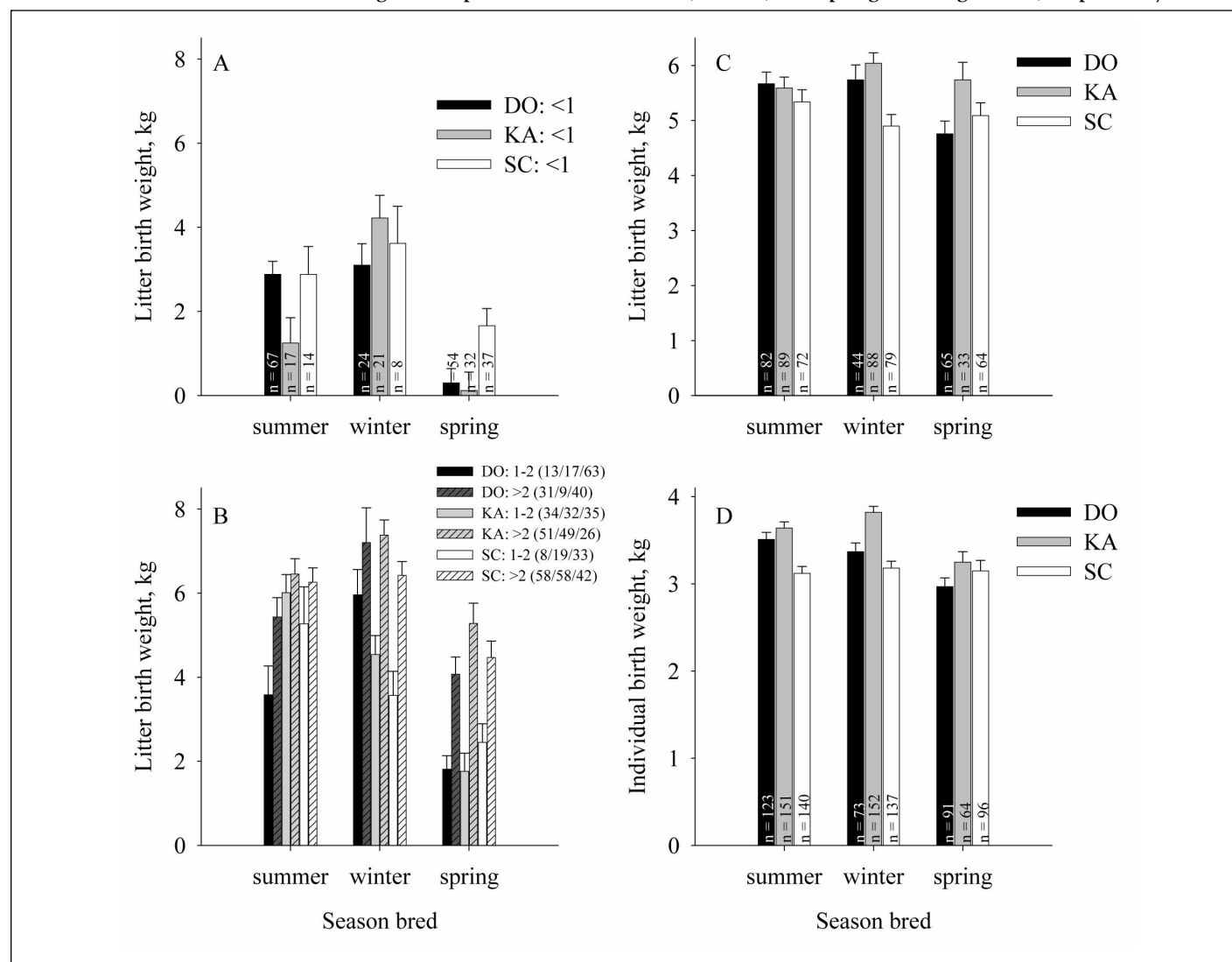


Figure 3. Least squares means and standard errors of litter birth weights for all ewes exposed at < 1 year of age (A), 1 – 2, or ≥ 2 years of age (B) (breed x age x season, $P < 0.002$), litter birth weight of ewes lambing (C; breed, $P < 0.002$), and individual birth weights of lambs (D; breed x season, $P < 0.02$). Breeds were Dorper (DO; black or dark gray bars), Katahdin (KA; light gray bars), and St. Croix (SC; white bars) and ewes were bred in summer, winter, or spring. Numbers of animals are indicated within bars or next to legends in parenthesis for summer, winter, and spring breeding season, respectively.



Burger, 1992). Pregnancy rates in KA ewes have been greater than 80 percent when bred in July or March compared to 98 percent when bred in November, but number of lambs born per ewe was lower (less than 1.6) than for those ewes bred in November (1.9; Wildeus, 2005).

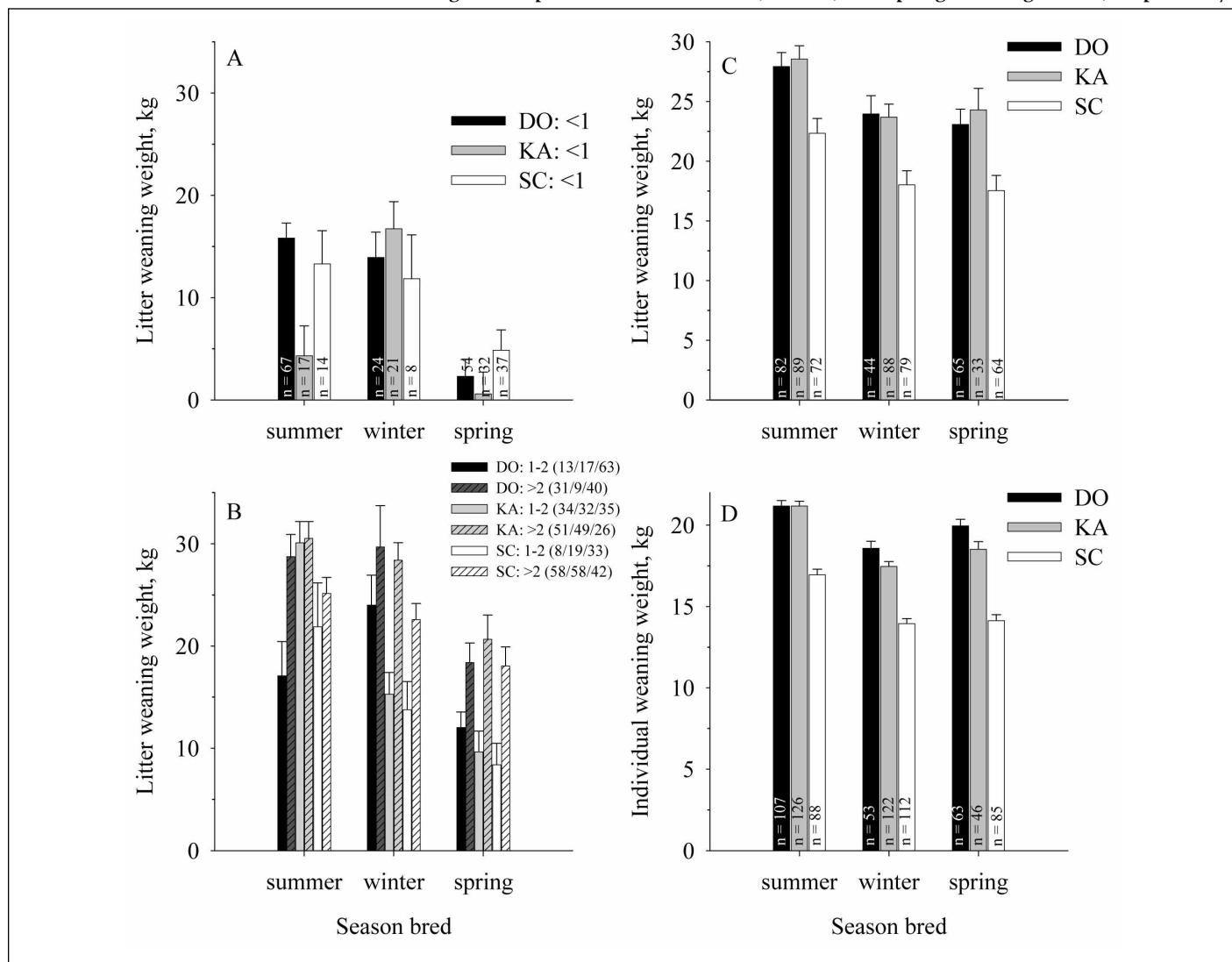
It was noted that body condition was good during spring and summer. Therefore, factors other than nutrition, such as summer heat stress, may have contributed to lower fertility during spring or summer breeding in DO and KA ewes. There may have been an initial heat stress leading to increased early embryonic mortality or delayed resumption of cyclicity. It has long been known

that chronic heat stress of pregnant ewes is associated with embryonic mortality and small lambs with poor survival rates (Moule, 1954; Yeates, 1956; Shelton, 1964a, b; Alexander and Williams, 1971). This suggests that DO ewes may be somewhat more susceptible to heat stress than SC ewes that had fewer lamb losses among seasons.

Survival of single and twin-born lambs to weaning was similar among seasons for KA and SC lambs (89 to 95%), but decreased in DO lambs from ewes bred in winter and spring compared with summer (82% vs. 98%; breed x season, $P < 0.003$). Weaning rate or the number of lambs weaned per ewe that lambled was

similar among breeds and seasons, but increased with age of ewe (< 1 year of age, 123%; 1 - 2-year old, 140%; ≥ 2 years of age, $162 \pm 5\%$; $P < 0.001$). Weaning weights of litters for all ewes exposed to a ram were greatest in winter-bred and older ewes and lowest in ewes < 1 year of age bred in spring (breed x age x season, $P < 0.001$; Figure 4A and B). For those ewes that lambled, litter weights were greatest for DO and KA ewes compared with SC ewes (DO, 24.9 kg; KA, 25.4 kg; SC, 19.3 ± 0.7 kg; $P < 0.001$), increased with age (< 1 year of age, 18.3 kg; 1 - 2-year old, 23.2 kg; ≥ 2 years of age, 28.1 ± 0.6 kg; $P < 0.001$), and were greatest for summer-bred ewes

Figure 4. Least squares means and standard errors of litter weaning weights for all ewes exposed at < 1 (A), 1 – 2, or ≥ 2 years of age (B) (breed x age x season, $P < 0.002$), litter weaning weights of ewes lambing (C; breed, $P < 0.002$), and individual weaning weights of lambs (D; breed, $P < 0.001$, season, $P < 0.001$). Breeds were Dorper (DO; black or dark gray bars), Katahdin (KA; light gray bars), and St. Croix (SC; white bars) and ewes were bred in summer, winter, or spring. Numbers of animals are indicated within bars or next to legends in parenthesis for summer, winter, and spring breeding season, respectively.



(summer, 26.3 kg; winter, 21.8 kg; spring, 21.5 ± 0.7 kg; $P < 0.001$; $P < 0.001$; Figure 4C). Similarly, individual weaning weights of DO and KA were greater than SC lambs ($P < 0.001$) and greatest in lambs from ewes bred in summer ($P < 0.001$; Figure 4D). Not surprisingly, individual weaning weights were greater in single-compared with multiple-born lambs ($P < 0.001$) and greater in KA and SC male compared with female lambs but similar between sexes for DO lambs (breed x sex; $P < 0.001$). Forage quality and quantity are often greater during late winter and early spring in Arkansas, because of growth of cool season grasses such as tall fescue and

winter annuals, which contribute to greater weaning weights. Brown and Jackson (1995) also determined that weaning weights of SC lambs were lighter during fall lambing than spring.

The forage base for this flock included endophyte-infected tall fescue, which has been shown to reduce pregnancy and calving rates in beef heifers (Brown et al., 1992; Gay et al., 1988) and increase body temperature of cattle (Porter and Thompson, 1992). Previously, we reported lower pregnancy rates in yearling, but not mature ewes, grazing tall fescue compared with bermudagrass (Burke et al., 2002). In addition to reduced ability for out-of-season breed-

ing, lower pregnancy rates during spring breeding in the current study could have been attributed to fescue toxins. Tropically-adapted breeds of cattle were less sensitive to fescue toxins than English breeds, likely because of greater heat tolerance (Brown et al., 1992, 2000; Browning et al., 1998). This could be true of the tropically-adapted SC, which experienced fewer pregnancy losses, compared with DO and KA ewes. Greater heat tolerance of SC is evident by lower rectal temperatures compared to that of Targhee, a wool breed, observed at elevated ambient temperatures (Horton et al., 1991).

Body weights of SC were less than

Figure 5. Least squares means and standard errors of relative efficiency of lamb production (kg lamb produced/kg ewe weight at breeding \times 100) at birth (breed \times age \times season, $P < 0.04$; A, B; season, $P < 0.001$; C) or weaning (breed \times age \times season, $P < 0.005$; D, E; season, $P < 0.001$; F) for all ewes exposed at < 1 (A and D), $1 - 2$, or ≥ 2 years of age (B and E) (breed \times age \times season, $P < 0.002$), or for all ewes lambing (C and F). Breeds were Dorper (DO; black or dark gray bars), Katahdin (KA; light gray bars), and St. Croix (SC; white bars) and ewes were bred in summer, winter, or spring. Numbers of animals are indicated within bars or next to legends in parenthesis for summer, winter, and spring breeding season, respectively.

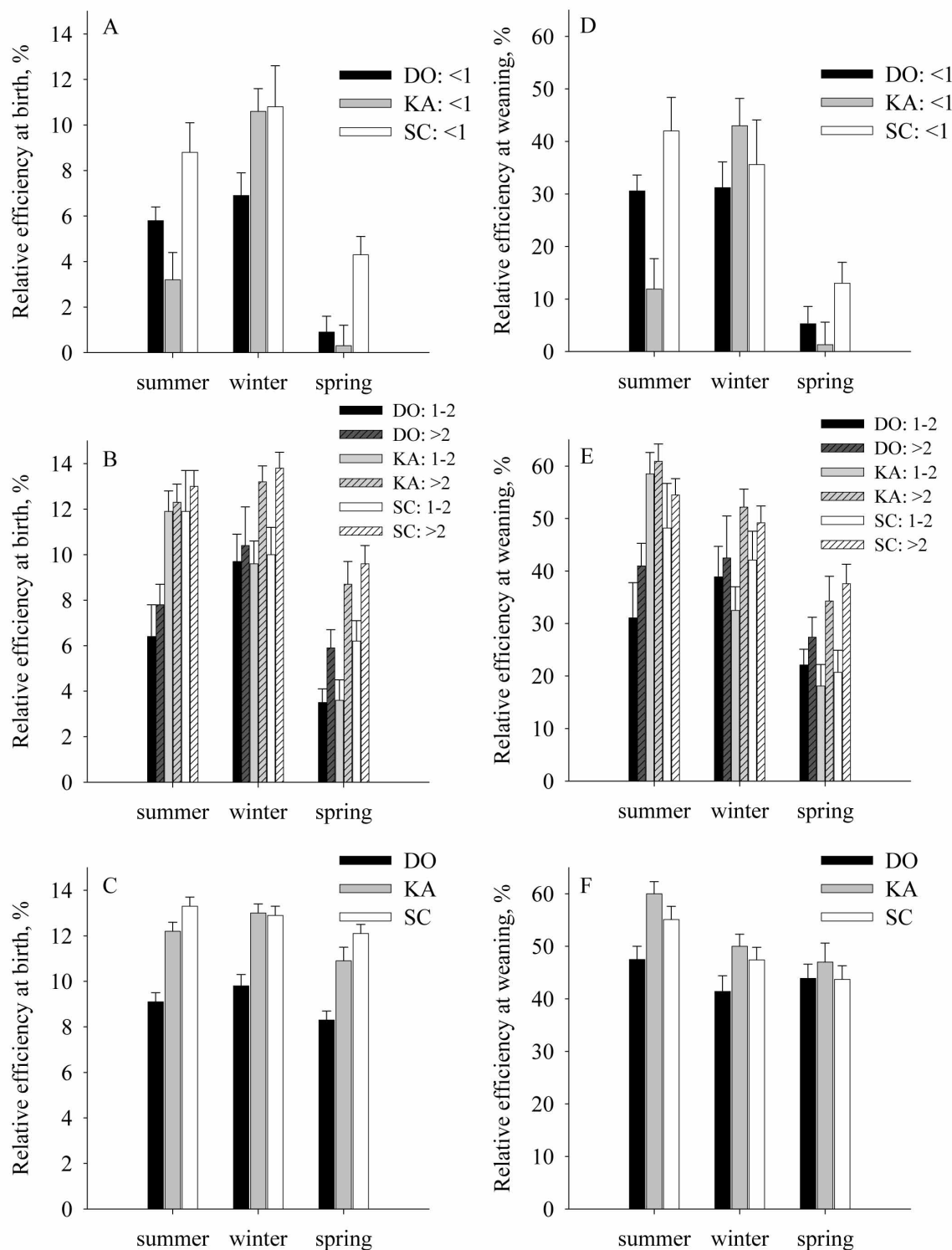


Table 2. Least squares means of body weight (kg) of Dorper (DO), Katahdin (KA), and St. Croix (SC) ewes < 2 or ≥ 2 years of age at ram introduction (breed x age, $P < 0.001$).

	DO		KA		SC	
	< 2 yr	≥ 2 yr	< 2 yr	≥ 2 yr	< 2 yr	≥ 2 yr
Breeding	50.4 ± 0.6	70.2 ± 1.0	43.7 ± 0.7	60.4 ± 1.1	35.6 ± 0.8	47.9 ± 0.8
Weaning	58.1 ± 0.7	72.1 ± 1.0	54.6 ± 0.9	59.4 ± 1.2	41.5 ± 1.1	50.4 ± 0.9

KA which were less than DO ewes at breeding and weaning ($P < 0.001$; Table 2). Body weights of older ewes were similar or slightly heavier at weaning than breeding. Body weight of mature DO, KA, and SC ewes ranged between 45 to 92 kg, 43 to 76 kg, and 33 to 60 kg, respectively. The range of body weights of DO and SC ewes was lighter than that cited by ASI (DO, 77 to 91 kg; KA, 54 to 72 kg; SC, 57 to 68kg; ASI, 2002).

The relative efficiency of lamb production at birth (breed x age x season, $P < 0.04$; Figures 5A and B) and weaning (breed x age x season, $P < 0.005$; Figures

5D and E) for all ewes exposed to a ram was greatest in older ewes and at birth for ewes bred in winter and at weaning for ewes bred in summer or winter compared with spring. For ewes that lambled, relative efficiency at birth was greatest for SC ewes (DO, 9.1%; KA, 12.0%; SC, $12.8 \pm 0.3\%$; $P < 0.001$) and lowest for spring bred ewes (season, $P < 0.001$; Figure 5C). By weaning, relative efficiency of production for ewes that lambled was greatest for KA ewes (DO, 44.4%; KA, 52.5%; SC, $48.6 \pm 1.5\%$; $P < 0.003$) and ewes bred in summer (season, $P < 0.001$; Figure 5F).

Conclusion

Hair and shedding breeds are most challenged with spring breeding compared with summer and winter breeding, but can provide lambs for market from breeding at this time if desired. All breeds that were two years or older were capable of out-of-season breeding, although early pregnancy rates were highest during winter breeding. Selection for fall born lambs may improve the genetic potential for out-of-season breeding in these breeds. Despite lower pregnancy rates and higher pregnancy losses for DO and KA ewes bred at < 1 year of age in the spring compared with late summer or winter, relative efficiency at weaning for DO ewes that lambled in spring was similar to other seasons and relative efficiency at weaning was greatest for KA ewes. In this warm, humid environment, KA ewes have the greatest production potential compared with SC and DO ewes.

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